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Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554.

Greetings:

Enclosed are 5 copies of a comment in response to the NOI on Internet and Interstate Information Services, Docket Numbers 96-262, 94-1, 91-213 and 96-263. My comment is also available at

`http://www.sims.berkeley.edu/~hal/Papers/phone.html`

Yours truly,

Hal R. Varian

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Dean

Local Exchange Congestion and Internet Service Providers

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1 Introduction

This is a short overview of the economic issues involving local exchange congestion due to dialup access of Internet service providers. It is based on a talk on this subject that I gave on March 7, 1997 at a conference entitled "Telecommunications Regulation and the Internet" at UC Berkeley. Background material can be found at

`http://alfred.sims.berkeley.edu/Regulate.`

2 Points of agreement

There are many points of agreement between the ISPs and the LECs. First, *Internet use and voice use have different peaks.* Voice use for business users peaks about 11 AM, and for residential users about 7 PM. Dial up Internet use peaks about 3 PM (i.e., after school) and 10 PM. If the peaks were synchronized, the problem of LEC congestion would be much more severe.

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Second, *most switch congestion is on the ISP side.* That is, the problems, at least in the past, have been with the switches servicing the ISP. These can be re-engineered by providing trunk lines to the ISP, similar to the way PBXs are served, but this re-engineering involves some cost. Also, the revenue implications are quite different since in many cases the LEC recovers some revenue from long-distance access charges from PBX service, but they do not recover access charges for ISP service.

Third, *there has been quite significant growth in second lines for dedicated Internet use.* This shows up quite clearly in the data presented in The Effect of Internet Use on the Nation's Telephone Network[1].

Fourth, *calls to ISPs have much longer duration.* The average voice call is about 4 minutes, and the average ISP call is about 20 minutes. Unlimited use packages offered by ISPs will almost certainly increase the duration of ISP calls.

Finally, everyone seems to agree that there is a serious *need for more data-friendly networks.* The current design of the POTS system is not appropriate for data traffic.

3 Current Trends

First, *Internet traffic will continue to grow.* UUNET claims their backbone traffic is doubling every 3 months. Aggregate backbone traffic seems to be doubling every 6 months.

Second, there will be *more dedicated lines for home computing,* at least if current pricing policies are maintained. Most homes in California have the potential for at least 2 lines, but 3 and 4 line usage is not uncommon. Additional lines are cheap if capacity is in place, but if new copper needs to be strung and new trunk lines the cost of additional lines could be quite high.

Third, *Internet calls will continue to increase in duration.* The simple fact of the matter is that there is no incentive to hang up. Unlimited local calling plus unlimited Internet access means that keeping the home computer up 24 hours a day is quite feasible.

Fourth, *new technologies may increase line use significantly.* At some ISDN rate hearings in California in September 1996, Microsoft demonstrated a

[1]http://www2.itic.org/itic/ppdocs.htm

feature that they indicated would be forthcoming in Windows NT. (See the September 27, 1996 news story from the San Francisco Examiner, "ISDN rate hearings thrown for a loop"[2].) The engineers took four 28.8 Kbs POTS modems and 4 POTS lines and plugged them in the back of a standard PC. The PC had a modified TCP/IP stack that split the IP packets into 4 streams that were sent to the 4 modems. This meant that the PC transferred data at ISDN rates, at a total telephone line charge of about $48 per month. If this technology becomes widespread, it could lead to a dramatic increase in the demand for POTS lines.

4 Data-friendly networks

Since everyone agrees that it would be nice to have a data-friendly network, we may well ask what this might mean. Here is a wishlist:

- Always on. This is because many of the traditional and new Internet applications are designed for workstations connected to a LAN.
- High bandwidth. ISDN speeds appear to be about the minimum acceptable speed.
- Low price. Total cost should be on the order of $40-$50 a month (e.g., $25 to ISP plus $20 to LEC?)

What are the technologies[3] that might be able to deliver these features?

- ISDN. It's here now at about $30 per month for residential use in California. This includes 200 hours of offpeak use per month.
- Cable. This offers the promise of shared 10 Mbs, always-on, shared bandwidth service at rates competitive with ISDN.
- ADSL. This offers dedicated asymmetric service at 1.5-6 Mbs downstream and 64-640 Kbs upstream. It also is always on and can coexist with POTS. It does not require a dedicated line.
- Data splitter. This is an interesting transition technology that splits data traffic off of POTS lines before the central switch, aggregates it, and sends it directly to an ISP.

[2]http://www.sfgate.com/cgi-bin/examiner/article.cgi?year=1996&month=09&day=27&article=BUSINESS8
[3]http://www.specialty.com/hiband/

5 Data splitter

One example of a data splitter is Nortel's Internet Thruway[4]. This something like a super modem that sits in front of the switch. It intercepts incoming calls, checks the phone number, and if the number is that of an ISP, does the A-D conversion and sends it off to the ISP. If the call is not a data call, it is sent to the standard phone switch.

In the FCC high bandwidth forum[5] Pacific Bell gave a rough estimate that a data splitter would cost about $45 per port per month. Note that in California an unlimited-use business telephone line costs about $15 per month and installing and maintaining a modem bank costs about $15 a month. This means that the data splitter would save the ISP about $30 a month, which is still short of the $45 cost.

However, there are some doubt about the $45 per person per port figure. Like everything else in telecommunications, the cost is almost entirely capacity costs, so that per capita costs depend strongly on the number of users. This $45 figure is presumably a breakeven price, so that more Internet users at a given central office would imply a lower per person cost.

5.1 Benefits of data splitter

A data splitter

- eliminates the need for analog-digital conversion;
- saves circuits in the switch;
- saves investment in additional POTS technology;
- may allow 56 Kbs modems to work at full speed;
- can work with POTS, ISDN, or ADSL. (In fact, a more sophisticated kind of data-splitter is required for ADSL.)

The main cost of a data splitter is that it is a new technology and therefore may have reliability problems. Since it goes in front of the switch and filters voice, it needs to be reliable and bug-free.

[4] http://www.nortel.com/pcn/solutions/ithruway.html
[5] http://www.fcc.gov

6 Incentives to adopt new technology

What does it take to get consumers and producers to adopt (voluntarily) a new technology such as a data splitter?

First, the consumers must benefit from the adoption:

The value of the new technology to the consumers minus the price of the new technology to the consumers must exceed the value of the old technology to the consumers minus the price the consumers pay for the old technology.

Secondly, the producers must benefit:

The revenue the producers receive from the new technology minus the cost of the new technology must exceed the revenue they would receive from the old technology minus the cost of the old technology.

It is important to recognize that the cost of the technology to the producer is not just the direct costs, but also includes congestion costs, etc.

Consider the following line of argument:

1. The data splitter itself doesn't provide any extra value for the consumer;
2. Hence the consumer would only choose to use this technology if its price is less than the price of the old technology.
3. If the producer receives the same price the consumer pays, it would only choose to adopt the new technology if the cost is less than the cost of the old technology.

If this line of argument is correct, the question then becomes: is the cost of the new technology cheaper than the congestion costs generated by the old technology? In the case under consideration, this may or may not be the case.

A good part of the problem lies with the fact that the "price paid by the consumer for the old technology" is a regulated price. This price in general does not reflect the actual costs of data use on the public switched network, due to the fact that it ignores the congestion costs. In some cases these costs may be small enough that they *can* be safely ignored, but if the congestion costs are large, ignoring the congestion costs could have a perverse impact on the incentives to adopt a new technology.

7 Making it work

There are six relevant variables: the value to the consumers of the old and new technology, the costs of the old and new technology, and the prices paid by the consumers and the producers. How can these be tweaked so as to make adoption of the new technology attractive to consumers and producers?

7.1 Consumer side

First, you could try to increase the value of the new technology to the consumer. One way to do this would be to cache Web pages near the data splitter. This would allow material to be distributed to the consumers *without* traversing the backbone networks.

This could also be a very nice business opportunity for the LEC. The network interconnection model is broken and will continue to be broken for some time. Performance will continue to be poor when data is transferred between networks. Cacheing the data close to the consumer can lead to dramatic performance increases.

Another nice feature of this sort of cacheing is that the LEC can provide demographic information about the consumers which could be very valuable to advertisers. There are restrictions about using *telephony* records in this way, but the LECs know the geographic area they serve and can easily cross tabulate this with census data.

Another way in which the data splitter service more useful to consumers is to exploit the feature that it is always on. Material could be downloaded during the day to be viewed in the evening, or vice versa.

Finally, it may be that 56 Kbs modems will actually work if they don't have to got through the switch, which implies substantially higher access speed for consumers. All of these features suggest that consumers might be willing to pay more for access via a data splitter.

The other relevant margin to work on is to restrict the value of the circuit-switched network for data traffic. A draconian solution would be to restrict the circuit-switched network to voice traffic only, but this is unlikely to be politically feasible, and would certainly be rather costly. One could also do things like requiring that the connection be automatically dropped if there were no activity for a certain period of time, etc., but overall, this does not appear to be a promising approach.

The third option is to raise the price of the old technology to the consumer. This is, of course, the proposed data access fee (DAF). If the consumer is imposing significant congestion costs on the network by data calls, then it is appropriate that the consumer faces the costs he is imposing on others, and a DAF can be justified on these grounds.

But the other side of the coin is that the consumers who use the data splitter are *not* imposing any congestion costs on the switch. Hence they should not be required to pay a DAF. They may, of course, pay a higher price due to the fact that they are receiving a more useful service, as outlined above. But there is no justification for a congestion fee since no congestion is being generated if a data splitter is being used.

7.2 Producer side

On the producer side, the first thing to consider is revenues. Essentially you would like to reduce the revenue from the old technology that the producer receives and increase the revenue from the new technology. So the producer should *receive* higher revenues from offering data-split service than from circuit-switched service. There is no reason why the producer should get a data access fee from providing POTS switching.

Now, it may be that the the increase in value to the consumer from the data splitter is high enough that the price they are willing to pay for this service is large enough to incent the producers to provide it. If so, there's no problem. But if these incentive are not sufficiently strong, it may be necessary to provide the producer with a DAF.

Note the problem: we want the consumers to pay less if they use the more efficient technology, but we want to producers to get more if they deploy the efficient technology. One way to achieve this is to use the DAF paid by the consumers who use the circuit-switched network for data to cross subsidize the provisioning of the data splitter technology.

This is effectively using the revenues from a Pigovian congestion tax on those who are causing congestion to provide an increase in network capacity. Under certain conditions, this is an efficient way to proceed; see MacKie-Mason, J. and Varian, H., "Pricing Congestible Network Resources," *IEEE Journal on Selected Areas in Communications*, 13, 7, (September 1995). This paper is also available online in PDF format[6].

[6]http://www.spp.umich.edu/spp/papers/jmm/Pricing_Congestible_Resources.pdf

The other thing one might do on the producer side is to find ways to reduce the cost of the data splitter. Competition might be helpful here; e.g., have people bid for the right to provide this service. The one worry would be that the data splitter sits at a critical point in the voice network, so it might be a bad idea to have multiple owners.

Another option is to co-locate a router with the data splitter. The LEC could own this router, which would put it a very good position in providing ISP service. Or they could allow several other ISPs to connect to the router for an appropriate fee. This fee could be determined by auction, for example. Making ISP/data market competitive in these way might count towards the "local competition" requirement for entering long-distance service.

8 Summary

This note has briefly described some of the considerations involved in local switch congestion and Internet service provision. It seems to be universally agreed that the current methods of integrating circuit-switching and packet-switching are not adequate for future growth and that it is necessary to move towards more data-friendly networks. I have examined some considerations that are relevant to voluntary adoption of new technology in this context.